Pelagic Seabird Populations off Southwestern Vancouver Island

K. Vermeer, R. Hay and L. Rankin
Canadian Wildlife Service

Institute of Ocean Sciences
Department of Fisheries and Oceans
Sidney, B.C. V8L 4B2

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By
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Canadian Wildlife Service

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ABSTRACT

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Marine bird surveys were conducted from oceanographic vessels off southwestern Vancouver Island during July and October 1984; March, May, June and November 1985; and June, July, August, September and October 1986. The birds utilizing the waters off southwestern Vancouver Island consist of a highly diverse group of visitors from breeding grounds in the Arctic, British Columbia, the Canadian prairie provinces, Chile and Oregon. Two peaks in bird density were observed, a minor one in early June and a major one in August and September. The peak in June consisted mostly of Sooty Shearwaters (Puffinus griseus), that in August-September of Cassin's Auklets (Ptychoramphus aleuticus), California Gulls (Larus californicus) and Sooty Shearwaters. The California Gull was the most numerous bird in September, its presence being frequently associated with fishing trawlers. Surprisingly, Sabine's Gull (Xema sabini) was the second most numerous gull species in September. The waters off southwestern Vancouver Island are a major fall migration and feeding stop for those two gull species. Recommendations are made to investigate the relationship between the food habits of the most common marine birds and oceanographic processes in this highly irregular bathymetric region.

Key words: marine birds, seabirds, SW Vancouver Island

RÉSUMÉ

Vermeer, K., R. Hay and L. Rankin. 1987. Pelagic seabird populations off southwestern Vancouver Island. Can. Tech. Rep. Hydrogr. Ocean Sci. No.87: iii + 26p.

Des observateurs à bord de navires océanographiques ont effectué des relevés d'oiseaux marins au large de la côte sud-ouest de l'île de Vancouver en juillet et octobre 1984, en mars, mai, juin et novembre 1985 et de juin à octobre 1986. La faune avicole qui fréquente cette région est composée d'un groupe très diversifié de visiteurs venant des aires de reproduction de l'Arctique, de la Colombie-Britannique, des prairies canadiennes, du Chili et de l'Orégon. On a observé deux pics dans la densité des oiseaux, soit un faible pic au début de juin et un plus fort en août et septembre. Le premier était surtout composé du puffin fuligineux (Puffinus griseus) tandis que le second, de l'alque de Cassin (Ptychoramphus aleuticus), du goéland de Californie (Larus californicus) et du puffin fuligineux. En septembre, le goéland de Californie était l'espèce la plus abondante; il a souvent été observé à proximité des chalutiers de pêche. Étonnamment, la mouette de Sabine (Xema sabini) venait au second rang pour l'abondance en septembre. La région constitue une importante zone d'alimentation et de transit au cours de la migration d'automne de ces deux espèces de goéland. Les auteurs présentent des recommendations pour l'étude des relations entre les habitudes alimentaires des principales espèces d'oiseaux marins et les processus océanographiques dans cette région dont les caractéristiques bathymétriques sont très irrégulières.

Mots-clés: oiseaux marins, oiseaux pelagiques, sud-ouest de l'île de Vancouver

INTRODUCTION

Aerial surveys of pelagic birds conducted along the outer west coast of British Columbia from June 1972 to March 1973 showed bird densities to be highest off southwestern Vancouver Island (Vermeer et al. 1983). During that period, large gulls and shearwaters were the most conspicuous birds observed. Although gulls were not identified to the species level from the air, a few surveys by boat indicated that California Gulls (Larus californicus) and Glaucous-winged Gulls (Larus glaucescens) were numerous off SW Vancouver Island during late summer and autumn. Besides gulls, Sooty Shearwaters (Puffinus griseus) were observed to be numerous in summer and autumn. Guzman and Myres (1983), who conducted an investigation on the distribution of shearwater species off the west coast of Vancouver Island, also observed many thousands of Sooty Shearwaters visiting the shelf waters there in May.

Since little quantitative data exists on pelagic bird numbers and species composition in waters off west Vancouver Island, we conducted shipboard investigations to determine seasonal bird use of that area in 1984, 1985 and 1986. We limit our discussion in this paper to the waters off the southwestern portion of Vancouver Island, indicated in Fig. 1, as that region was best covered during the sea cruises and has a quite irregular bathymetry, including two banks (LaPerouse and Swiftsure), which are known to be rich fishing areas. That pelagic seabird populations may be affected by fishing operations in these waters was a further incentive to our investigations. Such operations either benefit marine birds - when fishes are brought to the surface in nets, the birds can feed upon them - or harm the birds if they are caught and killed in the nets. Birds can also be negatively affected by fishing if that activity leads to a reduction or depletion of their prey.

METHODS

Area surveyed. The continental shelf region surveyed for pelagic seabirds off SW Vancouver Island encompasses 9,200 km^2. The northwestern boundary extends 60 km southwestward from Estevan Point (Fig. 1). The width of the study area off Vancouver Island is effectively constant, the offshore boundary parallels the Island's west coast. Both Barkley Sound and Juan de Fuca Strait have been excluded. A planimeter was used to calculate the area of the region surveyed. In the text we use the word "shelf" for waters between the Vancouver Island shore and the 200 m contour, and the term "shelfbreak" where waters become rapidly deeper than 200 m.

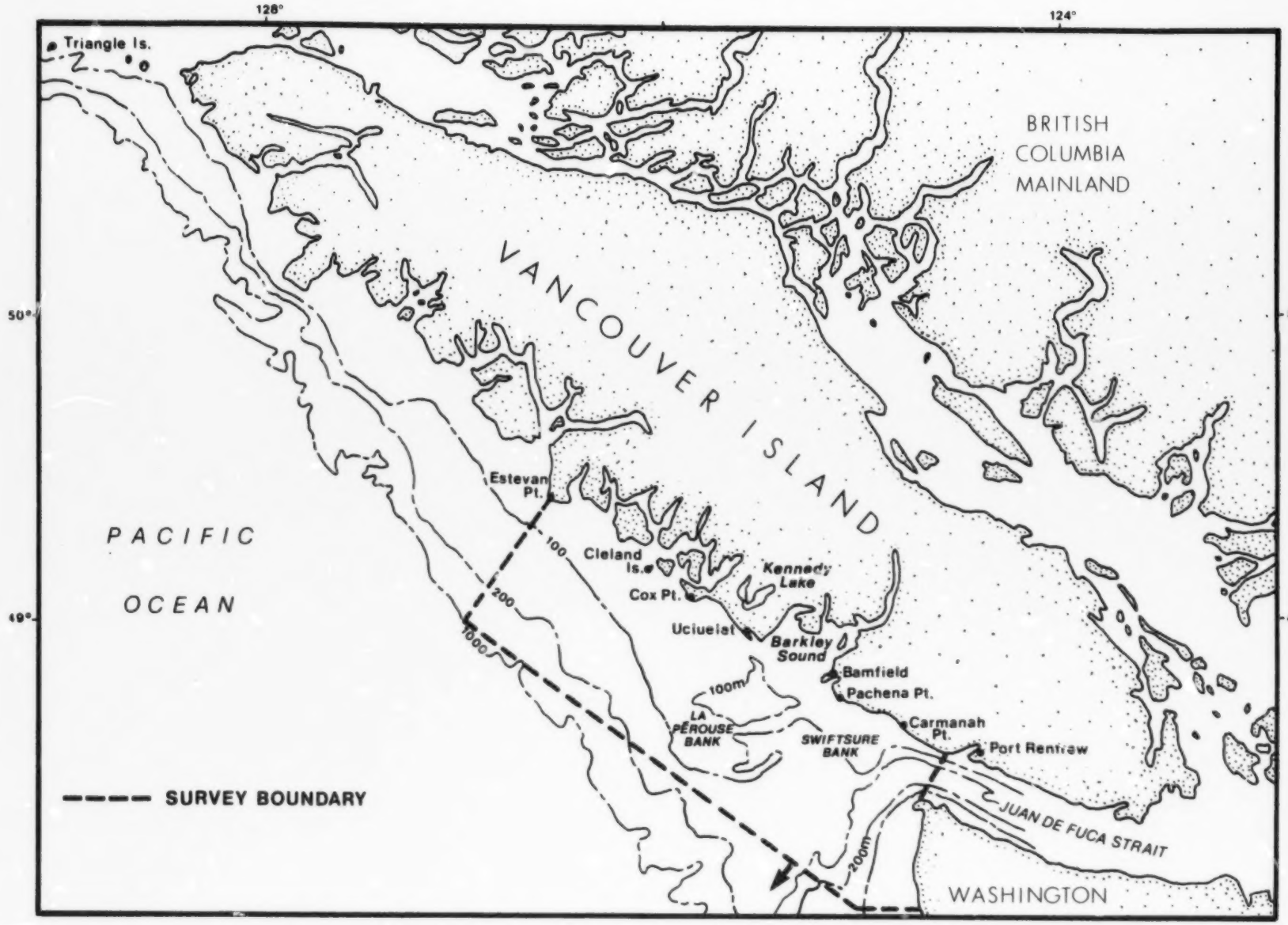

Figure 1. Survey region for marine birds off SW Vancouver Island.

Transects at sea. Observational methods were the same as those used by Vermeer and Rankin (1984, 1985). Transects were carried out only when the ship was travelling at greater than 5 knots during daylight. Observations were halted in heavy fog, rain or rough seas. The platform above the bridge (14 m above sea level) served as the usual point of observation. The sea was scanned with 7x35 or 8x40 binoculars in a 180 degree field forward, centered on the ship's bow. If the observer faced strong, direct sunlight, this field was scanned with the sun at the back. Birds which approached and followed the ship - such as large gulls and the Black-footed Albatross (Diomeda nigripes) - were counted only once in a transect; also such birds were counted only once per three transects if they continued to follow the ship.

The species and number of all birds sighted during transect counts were recorded. Birds identified to genus, and unidentified birds were noted as well. Estimates of large flocks were made due to the difficulty of counting each bird. Behavioural notes on birds (e.g. swimming, flying, feeding, etc.) were not kept. Observations halted within 1 km of the mainland and when the ship stopped its forward motion.

Transects were conducted for 10-minute periods. The location of the ship was recorded at the beginning and end of each transect. The date and time was also recorded for each transect. Ship speed and compass heading, percent cloud cover, wind speed and direction, wave height, precipitation, sun orientation and glare, and general location were recorded initially and updated as conditions changed.

Observations were made during October and July 1984; March, May, June, and November 1985; and June, July, August, September and October 1986. Five different observers contributed to the surveys. In total, 851 transects were conducted on 48 days over a linear distance of 2,677 km. Transects for each trip are shown in the Appendix (Figs. 1 through 11). Oceanographic vessels used for surveys were the CSS Parizeau, the CFAV Endeavor, and the MV John P. Tully. The research vessels were involved with other oceanographic work, which created a series of random transects over which the observers had no control. Transects were carried out whenever ship movements and weather permitted. This resulted in much variability of locations and number of transects.

Although we calculated density and standing stock for all seabirds by Sanger's (1972) method for previous surveys of pelagic birds off the British Columbia coast (Vermeer and Rankin 1984, 1985), we did not use that method in the present study as the area involved was small and its habitat varied considerably from inshore to offshore localities. Instead we show densities as the number of birds seen per km travelled by ship. Even those densities are dependent on the route the ship travelled from inshore to offshore areas. Since this is a preliminary study, hopefully leading to further and more thorough investigations, we are satisfied to show bird species composition and population trends, and have not analyzed the data statistically. Also, we have not analysed the distribution of birds in relation to bathymetry; we intend to report on this topic in a separate publication (Hay and Vermeer in preparation).

RESULTS AND DISCUSSION

1. Numbers of birds observed

Loons. Three species of loons were sighted: the Common Loon (Gavia immer), Pacific Loon (G. pacifica), and Yellow-billed Loon (G. adamsii). The Pacific Loon was the most numerous, but it was still found only irregularly and in small numbers (Table 1). Only the Common Loon breeds nearby. Loons were usually seen close to shore. The one Yellow-billed Loon recorded was an adult, observed on 17 July 1986, 4 km off Wickaninnish Bay.

Black-footed Albatross. Small numbers of Black-footed Albatross were observed from March through October, with a small peak occurring in June (Table 1). They were normally encountered seaward from the shelfbreak. The Black-foot is by far the most frequently seen albatross off the British Columbia coast (Vermeer and Rankin 1984). It is also the dominant albatross off Washington, Oregon (Sanger 1972, T.R. Wahl pers. comm.), California (Miller 1940, Yocom 1947, McHugh 1955) and in the Gulf of Alaska (Kenyon 1950).

Northern Fulmar. Northern Fulmars (Fulmarus glacialis) were found in all months of the study. Over 90 percent of the sightings were of dark phase birds. Fulmars were usually sighted at least 16 km offshore, with concentrations found at the shelfbreak and near large bottom-trawlers (actively fishing). Peak numbers were recorded in September (Table 1). The largest flock in the study area (about 500 birds) was seen on 18 September 1986 over the shelf; concentrations of 5,000 to 10,000 were recorded on the same date west of the study area at the shelfbreak (around trawlers). Northern Fulmars appear to be most numerous along the British Columbia and Washington coasts from July until November (cf. Vermeer and Rankin 1984, this study; T.R. Wahl pers. comm.). That large numbers were seen at the shelfbreak near trawlers suggests that they may have been attracted by fish offal. Fulmars are known to forage on offal from fishing vessels (Hatch 1978, Wahl and Heinemann 1979) as well as on fish and squid.

Sooty Shearwaters. Sooty Shearwaters were observed in all months of the study, although they were rare in November and March. They were found throughout the study area, but mostly on the shelf, with occasional large flocks seen inshore or at the shelfbreak. Peak numbers occurred in June and again in September (Table 1). Largest flocks were 12,030 on 9 June 1985 and 2,550 on 18 September 1986; both flocks were over the shelf. In the northeastern Pacific ocean, Sooty Shearwaters are most numerous over the shelf (Harrison 1982, Guzman and Myres 1983, Vermeer and Rankin 1984) where they apparently feed chiefly on fish (Chu 1982). The diet of Sooty Shearwaters of British Columbia has not yet been investigated.

Pink-footed Shearwaters. Pink-footed Shearwaters (Puffinus creatopus) were sighted from May through October, usually at least 16 km from shore. Their prime foraging area was the shelfbreak, with peak numbers found there in August (largest flock 160 on 24 August 1986). They were often associated with flocks of Sooty Shearwaters. Pink-footed Shearwaters are common visitors from central Chile, where they breed. The west coast of Vancouver Island appears to be the northernmost locality

Table 1 Number of marine birds observed off SW Vancouver Island

Bird categories	Mar 6-11, 1985	May 14-15, 1985	Jun 9-19, 1985	Jun 10-13 16-18, 1986	Jul 16-17, 1986	Jul 23-26, 1984	Aug 18, 23-24, 1986	Sep 9-11, 18, 1986	Oct 20-21, 1986	Oct 30-31, 1984	Nov 19, 21, 23, 26, 1985
Gaviidae (loons)	1	4	11	10	1	0	3	13	8	6	31
Diomedeidae (all Black-footed Albatross)	1	23	2	115	5	4	3	5	0	4	0
Procellariidae											
Northern Fulmar	28	29	2	76	329	13	591	3,852	167	145	46
Sooty Shearwater	1	794	12,929	342	737	896	643	11,241	1,474	316	14
Pink-footed Shearwater	0	0	0	27	28	41	368	13	27	1	0
Unid. and misc. shearwaters	0	0	0	14	14	0	0	4	34	0	0
Hydrobatidae (mostly Fork-tailed Storm-Petrel)	82	40	65	228	53	36	163	439	39	0	2
Phalacrocoracidae (cormorants)	7	3	2	26	3	6	0	32	8	0	64
Anseriformes	13	4	37	103	2	0	6	170	3	0	10
Scolopacidae (mostly phalaropes)	0	56	0	1	43	56	24	121	0	0	0
Laridae											
Glaucous-winged Gull	320	89	419	384	97	207	22	234	394	1	12
Herring and Thayer's Gulls	201	22	22	5	11	4	2	45	2,214	113	108
California Gull	0	0	0	11	972	1,902	677	32,859	11,552	0	0
Sabine's Gull	0	20	1!	0	2	1	56	2,586	650	0	0
Black-legged Kittiwake	728	30	0	1	1	0	0	0	669	39	40
Unid. large gulls	194	39	26	72	39	101	9	0	15	10	48
Misc. larids and stercorarids	0	1	11	6	14	1	39	21	14	1	0
Alcidae											
Common Murre	502	28	11	971	144	1,320	165	1,865	543	109	202
Rhinoceros Auklet	27	13	36	27	10	9	21	50	2	0	0
Marbled Murrelet	19	4	3	503	11	0	0	3	0	0	0
Cassin's Auklet	192	2	144	25	128	3	6,940	3,882	535	14	31
Unid. and misc. alcids	26	6	32	39	25	6	14	7	0	0	16
Unid. birds and passerines	9	5	8	0	0	2	0	31	1	0	1
Total number of birds	2,351	1,212	13,771	2,986	2,669	4,608	9,746	57,473	18,349	759	625
Total length of transects (km)	408.2	198.0	446.1	327.3	136.0	252.1	131.9	329.3	112.9	104.1	231.0
Average number of birds per km of transect	5.8	6.1	30.9	9.1	19.6	18.3	73.9	174.5	162.5	7.3	2.7

which they still regularly visit, as few are seen north of that region (Vermeer and Rankin 1984, 1985, Isleib and Kessel 1973, Kessel and Gibson 1978). Their distribution off British Columbia may be governed by water temperature and prey type. Ainley (1976) observed that the yearly abundance of those shearwaters off California correlated with maximum water temperatures. Nothing is known of the diet of Pink-footed Shearwaters in British Columbia waters.

Buller's Shearwaters. Buller's Shearwaters (Puffinus bulleri) were rarely observed in September-October 1986, scattered throughout the study area. They appear to prefer the shelfbreak and seaward of this zone. The largest flock was 25 on 21 October 1986 over the shelf. Buller's Shearwaters are visitors from New Zealand, where they breed at the Poor Knight Islands. They were first commonly seen off British Columbia by Sheppard (1976) in 1968. Since then they have been regularly observed there. Buller's Shearwaters were not observed during extensive surveys in Hecate Strait and Queen Charlotte Sound (Vermeer and Rankin 1984), perhaps as those regions constitute shallow shelfwaters, which the species appears to avoid.

Storm Petrels. Fork-tailed Storm-Petrels (Oceanodroma furcata) regularly occurred from March through October, mostly over waters at least 16 km from shore. Peak numbers were found in June, and again in August-September, over the shelfbreak (Table 1). The largest flocks recorded during the two periods were comprised of 220 birds on 12 June 1986 and 110 on 18 September 1986. Only a few Leach's Storm-Petrels (Oceanodroma leucorhoa) were observed over the shelf during March 1985 and November 1985. The scarcity of Leach's Storm-petrels is not surprising as they are generally associated with warmer waters off the shelf. During a marine bird survey from the British Columbia coast to Ocean Station "P" in August 1981, Vermeer (in Vermeer and Rankin 1984) observed a significant and positive correlation between Leach's Storm-petrel densities and surface water temperatures. Fork-tailed Storm-petrels, on the other hand, are known to inhabit colder shelf waters (Martin and Myres 1969, Gould 1983, Vermeer and Rankin 1984). Both storm-petrel species feed extensively on myctophid fishes and on the amphipod Paracallisoma coecus in waters off British Columbia (Vermeer and Devito ms.).

Mottled Petrel. A Mottled Petrel (Pterodroma expectata) was sighted once on 16 June 1986, 32km southwest of Clayoquot Sound over the shelf.

Cormorants. Pelagic Cormorants (Phalacrocorax pelagicus) and Brandt's Cormorants (P. penicillatus) were recorded irregularly, usually in small numbers near shore. Both species breed adjacent to the study area. Double-crested Cormorants (P. auritus) were observed once: a flock of 6 on 20 October 1986, 8 km offshore from Clo-oose.

Ducks and Geese. Five species occurred irregularly in the study area, with White-winged Scoters (Melanitta fusca) and Surf Scoters (M. perspicillata) making up the majority of the sightings. The largest flock of White-winged Scoters, recorded on 18 September over the shelf, consisted of 65 birds. Brant (Branta bernicula) were found during

migration: a flock of 70 was recorded on 18 September 1986 over the shelf. Mallard (Anas platyrhynchos) and American Wigeon (Anas americana) were sighted infrequently. All of these species usually occurred near shore, with only a few sightings over the shelf.

Sandpipers. Small flocks of several species were recorded between May and September. Most were seen inshore - except Red Phalaropes (Phalaropus fulicaria), which occurred over the shelfbreak, and Red-necked Phalaropes (P. lobatus), which were sighted throughout the study area. Other species that were seen are noted by their month of occurrence: Whimbrel (Numenius phaeopus) - May; Semipalmated Plover (Charadrius semipalmatus) - August; Sanderling (Calidris alba) - September; Black Turnstone (Arenaria melanocephala) - September; Least Sandpiper (Calidris minutilla) - May and July-September; and Western Sandpiper (Calidris mauri) - May and July-September. Some sandpipers (except phalaropes) were attracted to the ship as a potential rest point during their migration; Semipalmated Plover, Least Sandpiper, and Western Sandpiper actually landed on the ship for rest.

Stercorarids. Pomarine Jaegers (Stercorarius pomarinus) were recorded from June through September, and Parasitic Jaegers (S. parasiticus) from July through October. The former species was found most frequently over the shelfbreak, whereas the latter usually occurred seaward of the shelfbreak. Their partitioning in offshore waters was due primarily to the usual foraging zone of the bird species which was kleptoparasitized. Pomarine Jaegers harassed Sabine's Gulls (Xema sabini), whereas Parasitic Jaegers vicitimized Arctic Terns (Sterna paradisaea). Numbers for both of these jaeger species peaked in August-September. Long-tailed Jaegers (S. longicaudus) were encountered rarely. Individual birds were seen on 24 August 1986 and on 18 September 1986 over the shelf; these birds normally migrate far offshore, preying on Arctic Terns. A South Polar Skua (Catharacta maccormicki) was sighted once on 9 September 1986, 29 km southwest of Nitinat Narrows.

Glaucous-winged, Herring and Thayer's Gulls. Glaucous-winged Gulls regularly occurred throughout the study area. They were most common inshore and around fishboats engaged in fishing. Numbers peaked in June, during the nesting season, and again in October, during the post-breeding dispersal (Table 1). This is the only gull species that breeds on the British Columbia coast (Drent and Guiguet 1961).

Herring Gulls (Larus argentatus) were irregular visitors from May to September, and were also common from October to March. They were normally found at least 16 km offshore, with some individuals straying inshore. Sub-adults and first-year birds were found in summer, whereas winter populations consisted primarily of adults.

Thayer's Gulls (Larus thayeri) were only found from October to March and then outnumbered Herring Gulls by a 10 to 1 margin. The largest flock recorded was 1,000 on 21 October 1986 over the shelf. Adults predominated among the birds observed.

California Gull. The California Gull was found only from June through October; however, in mid-July and from September to mid-October, this was the most numerous bird seen in the study area (Table 1). Peak numbers were recorded in September and October, both inshore and over the shelfbreak (Table 1). Largest flocks recorded were 10,000 on 18 September 1986, 5 km off Nitinat Narrows, and 8,000 on the same date over the shelf (around trawlers). During the nesting season in June, only sub-adults and second-year birds were sighted. From July through September, adults foraged mostly inshore, while first-year birds were found over the outer shelf and at the shelfbreak, especially around fishboats. In October adults predominated, with some second-year birds found offshore as well. California Gulls are common visitors to the British Columbia coast from mid July until the end of October.

Sabine's Gull. Sabine's Gulls were recorded on their migration (May to mid-June and August to October), with peak numbers sighted in September-October (Table 1). They normally occurred at least 16 km offshore; largest concentrations were found at the shelfbreak, over irregularities on the shelf (a flock of 650 was observed on 21 October 1986), and at Swiftsure Bank (flocks of 500 and 977 were observed on 9 and 18 September 1986, respectively). There were only two sightings of this gull in July.

Black-legged Kittiwake. Black-legged Kittiwakes (Rissa tridactyla) were regularly sighted over the shelf, with peaks noted during migration in October and March (Table 1). Adults then predominated. There were only a few records of non-breeding sub-adults in June and July. Largest flocks observed were 158 on 10 March 1985 and 500 on 20 October 1986, both over the shelf.

Other Gulls. Five other gull species were recorded in the study area. Western Gulls (Larus occidentalis) occurred regularly in small numbers from inshore to the shelfbreak. First-year birds were sighted in July, being replaced by adults in August-October. Bonaparte's Gulls (L. philadelphia) were found twice over the shelfbreak: single birds were noted on 16 July 1986 and on 10 September 1986. Ring-billed Gulls (L. delawarensis) were rarely found, associated with flocks of California Gulls. One first-year bird was sighted on 28 August 1986, 53 km southwest of Pachena Point; two more were sighted on 10 September 1986, 16 km southwest of Barkley Sound. Heermann's Gulls (L. heermanni) were recorded only in July and October (although they are more common on and near shore): two birds on 23 July 1984 and another two on 20 October 1986, both over the shelf. An adult Slaty-backed Gull (L. schistisagus) was observed on 20 October 1986, 8 km southwest of Carmanah Point. It is interesting to note that no Mew Gulls (L. canus) were recorded in the study area, although these gulls breed nearby (e.g. Kennedy Lake, Vermeer and Devito 1986) and are commonly found both along the British Columbia shoreline and over inland coastal waters (Vermeer et al. 1983).

Terns. Two tern species were sighted in the study area. Arctic Terns were common in small numbers from July through September. They were usually seen at least 16 km offshore, being more common far offshore. The peak concentration was observed in August-September at the shelfbreak and seaward of this zone. Caspian Terns (S. caspia) were sighted once: a flock of 4 was found on 11 June 1985 over Loudoun Channel, at the entrance

to Barkley Sound. Common Terns (S. hirundo) were not noted, although they are common from August through October over inland coastal waters in southern British Columbia.

Alcids. Common Murres (Uria aalge) regularly occurred on the shelf and inshore, usually in small feeding flocks of 10 to 20 birds. A few murres breed nearby, but most nesting is concentrated in the Scott Island group near the northern tip of Vancouver Island (Vermeer 1976a, b). Numbers peaked in the study area in March and again in June through October (Table 1). The largest flocks sighted were 359 and 391 on 24 July 1984 (3 km off Ucluelet and 4 km off Cox Point, respectively), and 690 on 11 June 1986 (4 km off Cox Point).

Rhinoceros Auklets (Cerorhinca monocerata) were found in small numbers from March through September, over the shelf and shelfbreak. The nearest large breeding colonies are on Destruction Island in northern Washington, and on Triangle Island near the northern tip of Vancouver Island, but several hundred pairs also nest on Cleland Island, adjacent to the study area (Vermeer 1979).

Marbled Murrelets (Brachyramphus marmoratus) were observed inshore in summer (March through September). Peak numbers occurred in June (Table 1). The largest flocks sighted were 158 and 235 on 11 June 1986, 4 km off Cox Point. Marbled Murrelets are known to prefer inshore waters and likely breed in old-growth forest adjacent to the study area (Sealy and Carter 1984).

Cassin's Auklets (Ptychoramphus aleuticus) were regularly oberved from March through October; fewer were recorded in October and November. Peak numbers were encountered in August over the shelfbreak; at this time this alcid was the most common bird there (Table 1). Five flocks totalling 5,990 birds were sighted on 24 August 1986. These auklets are the most numerous nesting seabirds in British Columbia; the largest breeding colony in the world, with about 360,000 breeding birds, is found on Triangle Island (Vermeer et al. 1979). Only a few hundred pairs nest adjacent to the study area (Campbell 1976).

Three additional species of alcids were recorded. Ancient Murrelets (Synthliboramphus antiquus) were found irregularly in small numbers in March and from June through September, normally at the shelfbreak. This alcid breeds abundantly in the Queen Charlotte Islands, but it does not breed adjacent to the study area (Vermeer and Lemon 1986). Tufted Puffins (Fratercula cirrhata) were found from May through September in small numbers. They usually feed offshore; in the study area, they occurred from the shelfbreak seaward, with occasional sightings inshore. Pigeon Guillemots (Cepphus columba) were only noted rarely, both inshore and over the shelf. They usually frequent the waters close to shore.

Passerines. A few passerines were observed from June through October. These birds were attracted to the ship as a rest point during their migration. Species seen were: Rufous Hummingbird (Selasphorus rufus), Golden-crowned Kinglet (Regulus satrapa), European Starling (Sturnus vulgaris), Orange-crowned Warbler (Vermivora celata), Yellow-rumped Warbler (Dendroica coronata), Townsend's Warbler (Dendroica

townsendi), Savannah Sparrow (Passerculus sandwichensis), and Lincoln's Sparrow (Melospiza lincolnii). Most of these birds rested on the ship for a short time, and then departed; a few however, died on board from exposure and exhaustion.

2. Fluctuations in densities of the three most numerous species

Overall bird densities, by month are shown in Table 1. Two density peaks occurred, a minor one in early June, and a major one in August, September and October. The one in June is mostly made up of Sooty Shearwaters, which peaked again in September (Table 2). These two peaks result from the spring and autumn migration, respectively, of the Sooty Shearwater from its nesting colonies in New Zealand and perhaps at Cape Horn, Chile. Wahl (pers. comm.) has observed a similar spring and autumn peak of Sooty Shearwaters off the Washington coast. The autumn peak of this shearwater has been observed to be less pronounced off northern British Columbia (Vermeer and Rankin 1984).

In late August, Cassin's Auklets showed the highest density of any species observed (Table 2). In August, adults and their young leave their large colony on Triangle Island as well as other nesting sites in the Queen Charlotte Islands. The high density observed in August may therefore reflect dispersal and southward migration from their northern colonies. Autumn migration of those auklets apparently continues throughout September and October; however, it decreases considerably by the end of October, as evidenced from the low densities observed at that time (Table 2).

The highest bird densities observed throughout the entire study were those for California Gulls in September (Table 2). California Gulls leave their colonies in Alberta in July, the adults earlier than juveniles (Vermeer 1970). Color-banded juveniles from a colony at Miguelon Lake, Alberta, have been seen near Nanaimo, on the British Columbia coast in August (Vermeer 1970). Adult California Gulls, which arrive in British Columbia in July, derive from colonies in the Canadian prairie provinces, where they breed by the tens of thousands (Vermeer 1970). Although some California Gulls linger at different inshore localities on the British Columbia coast, most gulls migrate to the west coast of Vancouver Island, where they can be seen by the thousands on beaches from July into October. Although Robertson (in Vermeer et al. 1983) did not determine exact numbers and proportions of off-shore feeding California and Glaucous-winged Gulls, he suggested that the former were more numerous. Our surveys confirm Robertson's earlier observations. Wahl (pers. comm.). also found California Gulls to be numerous off the Washington coast from the second half of July until early November. The waters off SW Vancouver Island and northern Washington are a major fall migration and feeding stop for these gulls. By November most California Gulls have left that region for the west coast of California and Mexico (Vermeer 1970). From November to March, these gulls are also seen mostly offshore, at Baja California (J.R. Guzman, pers. comm.).

Table 2 Number of marine birds observed per 100 km of transect off SW Vancouver Island

Bird categories	Mar 6-11, 1985	May 14-15, 1985	Jun 9-19, 1985	Jun 10-13, 16-18, 1986	Jul 16-17, 1986	Jul 23-26, 1984	Aug 18, 23-24, 1986	Sep 9-11, 18, 1986	Oct 20-21, 1986	Oct 30-31, 1984	Nov 19, 21, 23, 26, 1985
Gaviidae (loons)	0.2	2.0	2.5	3.1	0.7	0.0	2.3	3.9	7.3	5.8	13.5
Diomedeidae (all Black-footed Albatross)	0.2	11.6	0.4	35.2	3.7	1.3	2.3	1.5	0.0	3.8	0.0
Procellariidae											
Northern Fulmar	6.8	14.6	0.4	23.2	241.9	5.2	454.6	1,167.3	151.8	139.4	20.0
Sooty Shearwater	0.2	401.0	2898.8	104.6	541.9	355.5	494.6	3,406.4	1,340.0	303.8	6.1
Pink-footed Shearwater	0.0	0.0	0.0	8.3	20.6	16.3	283.1	3.9	24.5	1.0	0.0
Unid. and misc. shearwaters	0.0	0.0	0.0	4.3	10.3	0.0	0.0	1.2	30.9	0.0	0.0
Hydrobatidae (mostly Fork-tailed Storm-Petrel)	20.1	20.2	14.6	69.7	39.0	14.3	125.4	133.0	35.5	0.0	0.9
Phalacrocoracidae (cormorants)	1.7	1.5	0.4	8.0	2.2	2.4	0.0	9.7	7.3	0.0	27.8
Anseriformes	3.2	2.0	8.3	31.5	1.5	0.0	4.6	51.5	2.7	0.0	4.3
Scolopacidae (mostly phalaropes)	0.0	28.3	0.0	0.3	31.6	22.2	18.5	36.7	0.0	0.0	0.0
Laridae											
Glaucous-winged Gull	78.4	44.9	93.9	117.4	71.3	82.1	16.9	70.9	358.2	1.0	5.2
Herring and Thayer's Gulls	49.3	11.1	4.9	1.5	8.1	1.6	1.5	13.6	2,012.7	108.7	47.0
California Gull	0.0	0.0	0.0	3.4	714.7	754.8	520.8	9,957.3	10,501.8	0.0	0.0
Sabine's Gull	0.0	10.1	2.5	0.0	1.5	0.4	43.1	783.6	590.9	0.0	0.0
Black-legged Kittiwake	178.4	15.2	0.0	0.3	0.7	0.0	0.0	0.0	608.2	37.5	17.4
Unid. large gulls	47.5	19.7	5.8	22.0	28.7	40.1	6.9	0.0	13.6	9.6	20.9
Misc. larids and stercorarids	0.0	0.5	2.5	1.8	10.3	0.4	30.0	6.4	12.7	1.0	0.0
Alcidae											
Common Murre	123.0	14.1	2.5	296.9	105.9	523.8	126.9	565.2	493.6	104.8	87.8
Rhinoceros Auklet	6.6	6.6	8.1	8.3	7.4	3.6	16.2	15.2	1.8	0.0	0.0
Marbled Murrelet	4.7	2.0	0.7	153.8	8.1	0.0	0.0	0.9	0.0	0.0	0.0
Cassin's Auklet	47.0	1.0	32.3	7.6	94.1	1.2	5,338.5	1,176.4	486.4	13.5	13.5
Unid. and misc. alcids	6.4	3.0	7.2	11.9	18.4	2.4	10.8	2.1	0.0	0.0	7.0
Unid. birds and passerines	2.2	2.5	1.8	0.0	0.0	0.8	0.0	9.4	0.9	0.0	0.9

The chief prey of California Gulls in the offshore environment has not been identified, but they frequently forage opportunistically on fish caught by trawlers. Wahl (1977) observed flocks of these gulls feeding around his research vessel at night. The vessel's work lights were utilized by the gulls to catch 10-14 cm Pacific Sauries (Cololabis saira) when the fish approached the surface. Adult gulls were much more successful catching them than were immature gulls.

Why California Gulls feed farther offshore than Glaucous-winged Gulls is unknown, but may relate to intraspecific competition and behavioural differences. The California Gull, which is smaller than the Glaucous-winged, may have to forage farther offshore to reduce competition with the latter. California Gulls may also be more efficient foragers on fish than are the Glaucous-winged Gulls (see Wahl 1977). Vermeer (1970) observed the species' feeding dexterity near the nesting grounds; the gulls snatched ducklings from the water's surface and annihilated whole broods within a few minutes, even through the female ducks defended vigorously. Furthermore, California Gulls soar at greater altitudes than do Glaucous-winged Gulls (Vermeer unpubl. obs.). This behaviour may aid them to spot fish boats at greater distances.

CONCLUSIONS AND RECOMMENDATIONS

The shipboard surveys off SW Vancouver Island show that the California Gull, Sooty Shearwater and Cassin's Auklet were the most numerous species. The Pink-footed Shearwater was the second most common shearwater, and the waters off SW Vancouver Island appear to be the northernmost locality at which this bird is frequently seen. The Common Murre was the second most numerous alcid. Most of those murres may derive from their large breeding colonies in Oregon (see Vermeer 1983). Sabine's Gull was the second most numerous gull species observed in September; we do not know of any other offshore locality where this gull has been seen during its migration in such large numbers as off SW Vancouver Island. The waters off SW Vancouver Island are an important feeding stop for Sabine's Gulls on the way from their arctic breeding grounds to their winter quarters off Peru and northern Chile. It is interesting that many species observed off SW Vancouver Island are visitors from nesting colonies in the Arctic, British Columbia, Canadian prairie provinces, Chile, New Zealand and Oregon. At present we do not know which factors attract those birds to the waters off SW Vancouver Island; an abundance of prey and/or oceanographic parameters which make that prey available are likely factors. The region has a highly irregular bathymetry - banks and troughs, which can influence the speed and direction of local currents and the presence of upwelling. To understand fully the importance of the region to the visiting seabirds, one must examine the food habits of the birds and the processes which make that food available.

In 1987, the Department of Fisheries and Oceans plans to initiate a study on the survival of salmon in Barkley Sound and in adjacent waters off SW Vancouver Island. Salmon predation by seabirds is considered to be an aspect of that investigation. To obtain a more complete knowledge of fisheries-seabird interactions in the region, we recommend that the total diet (not only that of salmon) of the most common seabirds be examined in relationship to oceanographic processes.

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APPENDIX

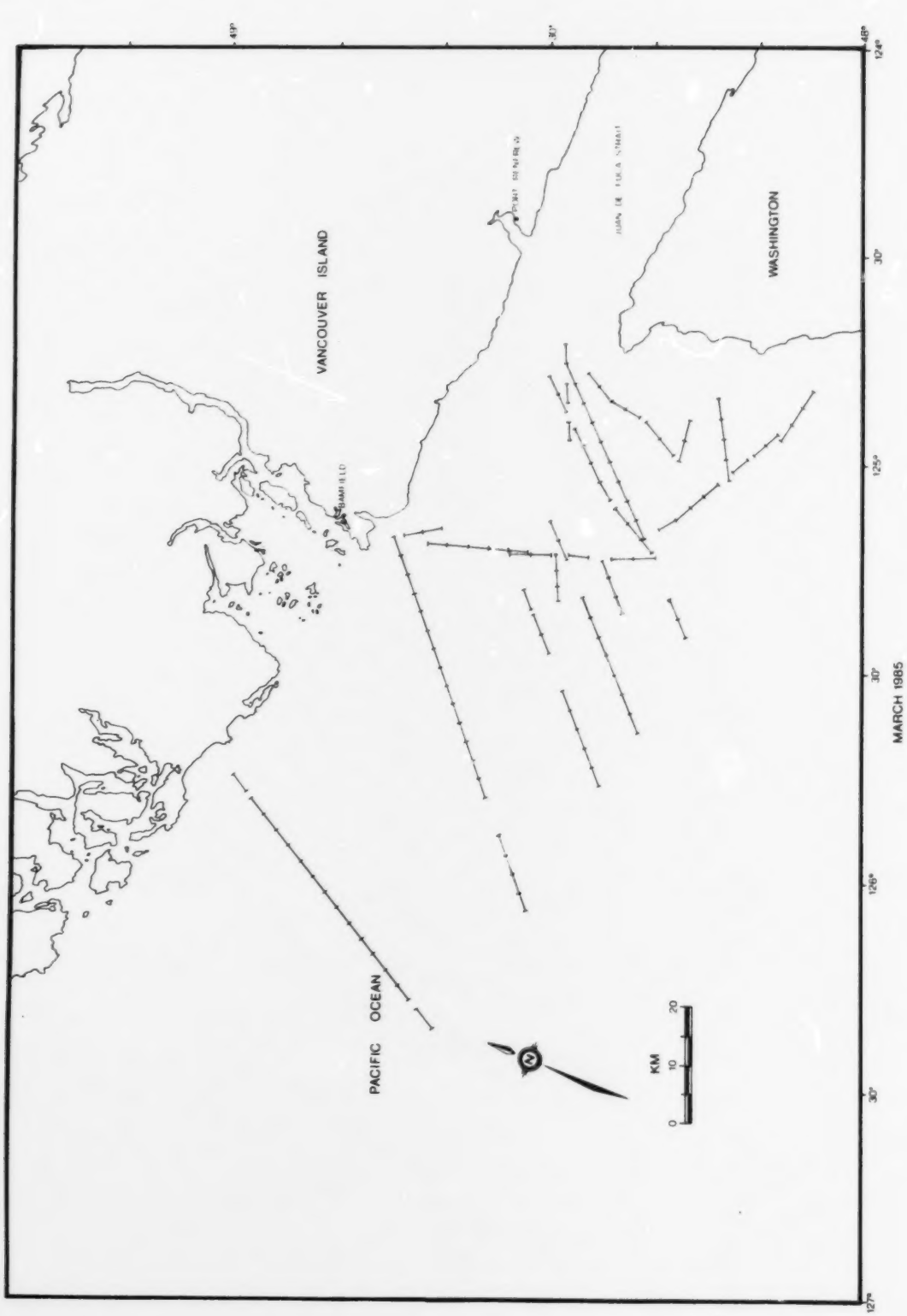


Figure 1. Location of survey transects during observations of marine birds off SW Vancouver Island, March 1985.

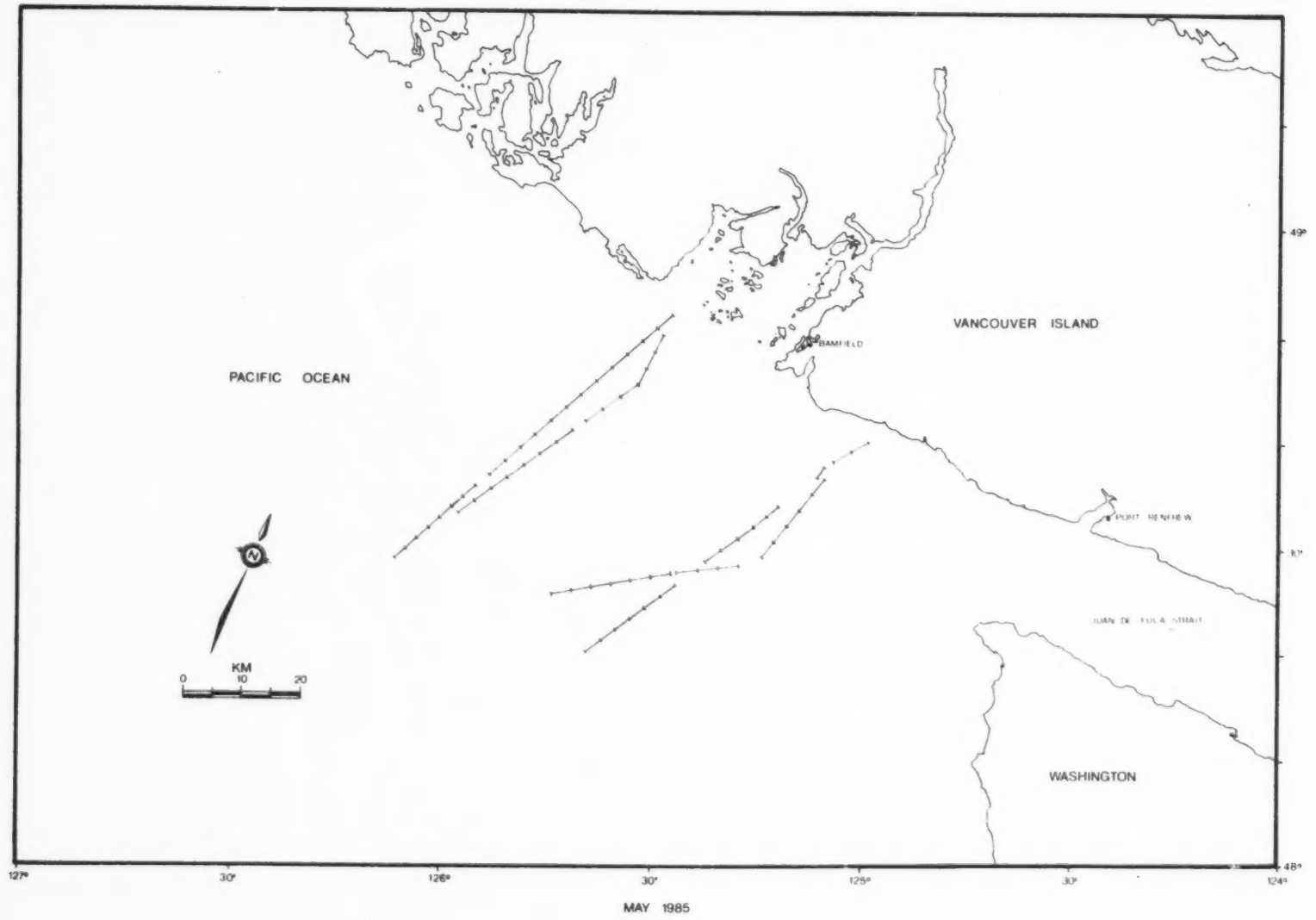


Figure 2. Location of survey transects during observations of marine birds off SW Vancouver Island, May 1985.

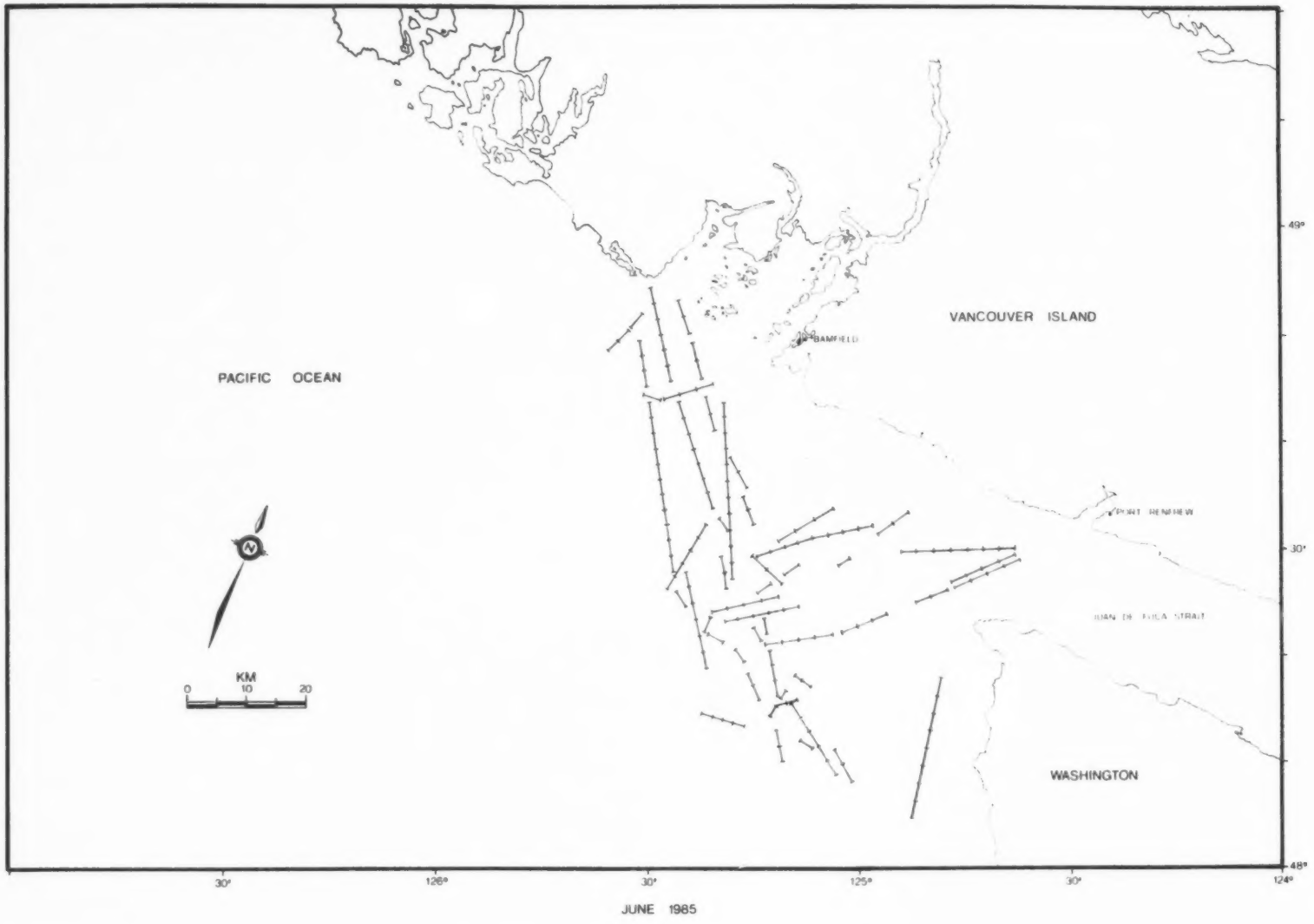


Figure 3. Location of survey transects during observations of marine birds off SW Vancouver Island, June 1985.

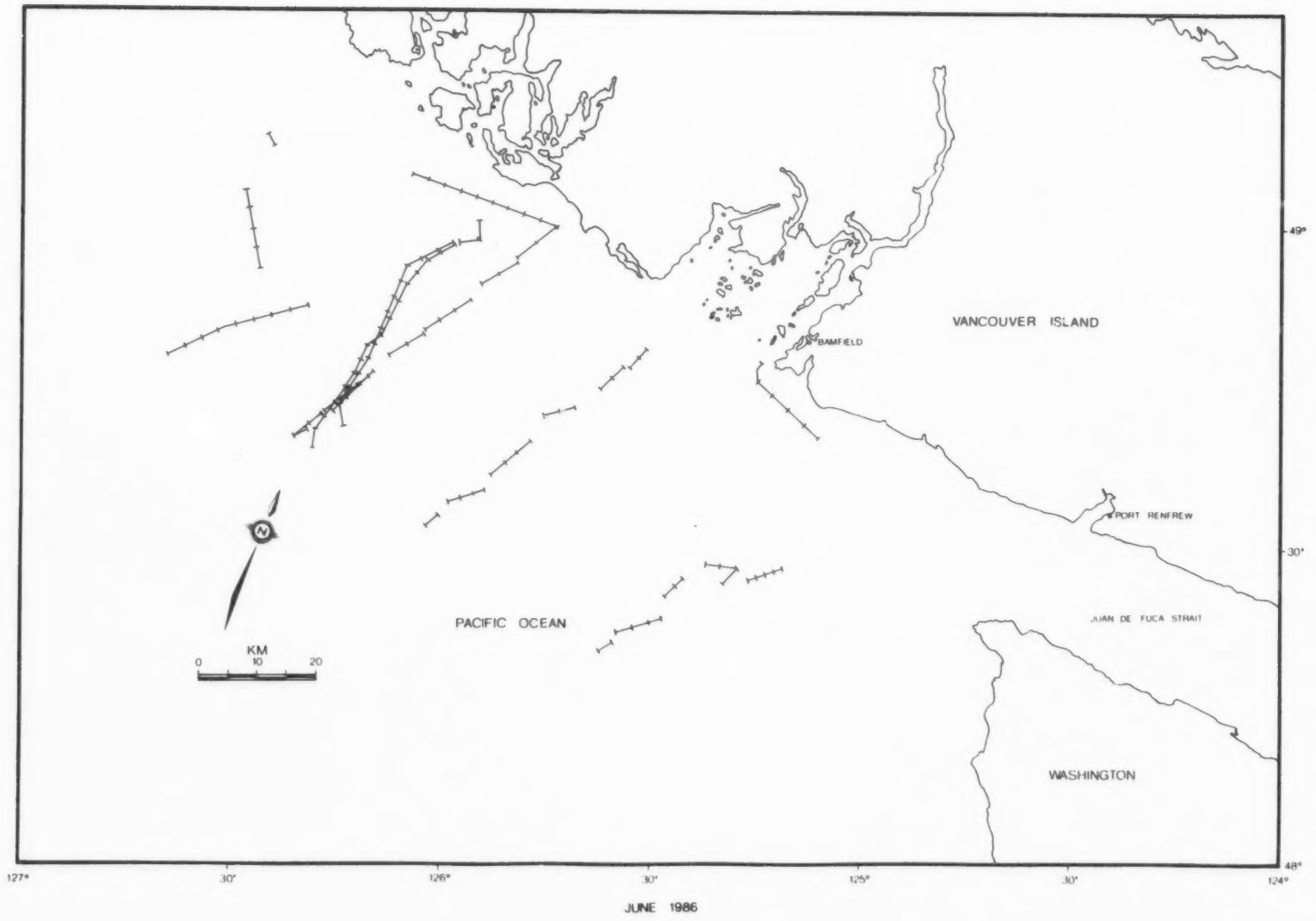


Figure 4. Location of survey transects during observations of marine birds off SW Vancouver Island, June 1986.

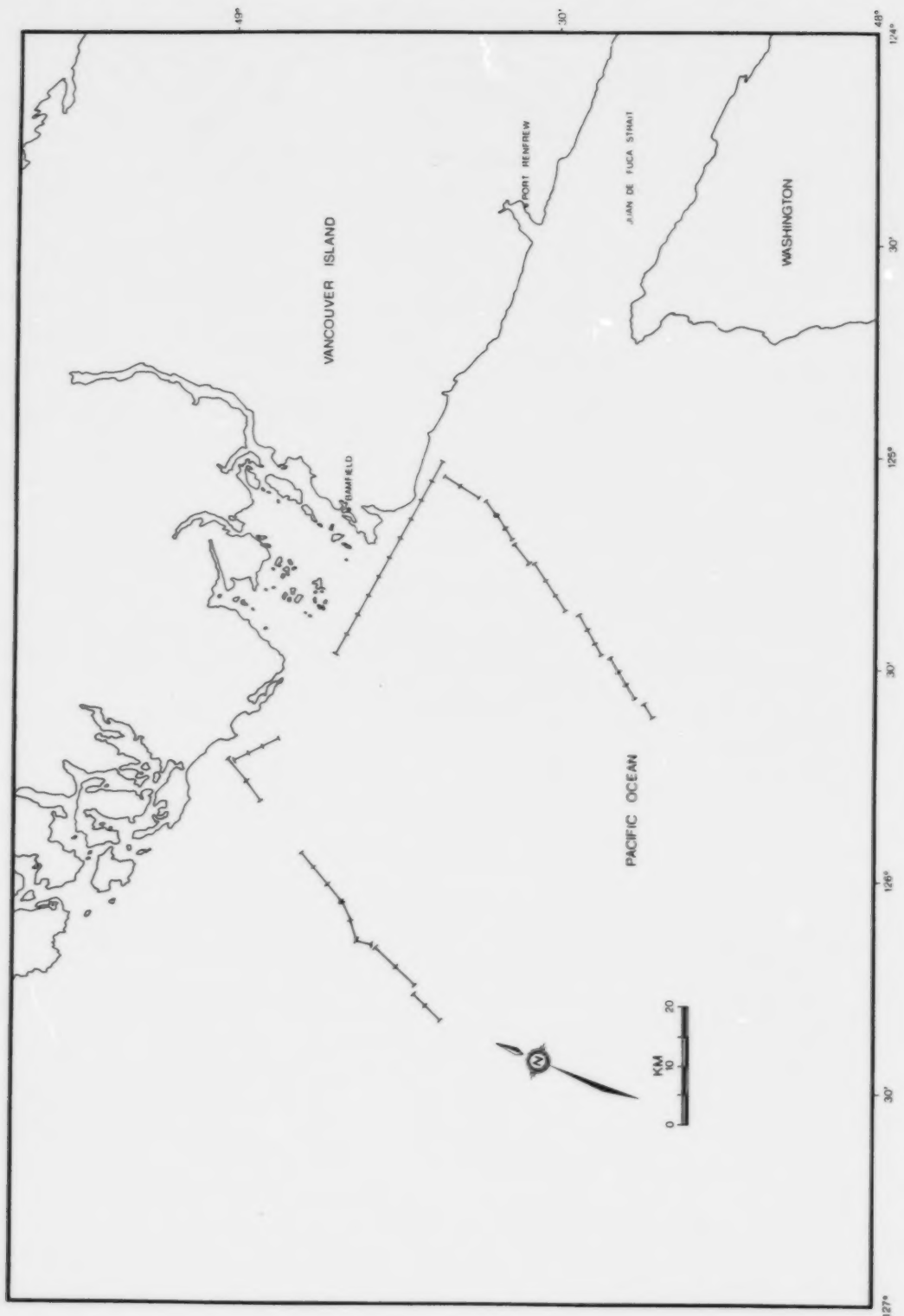
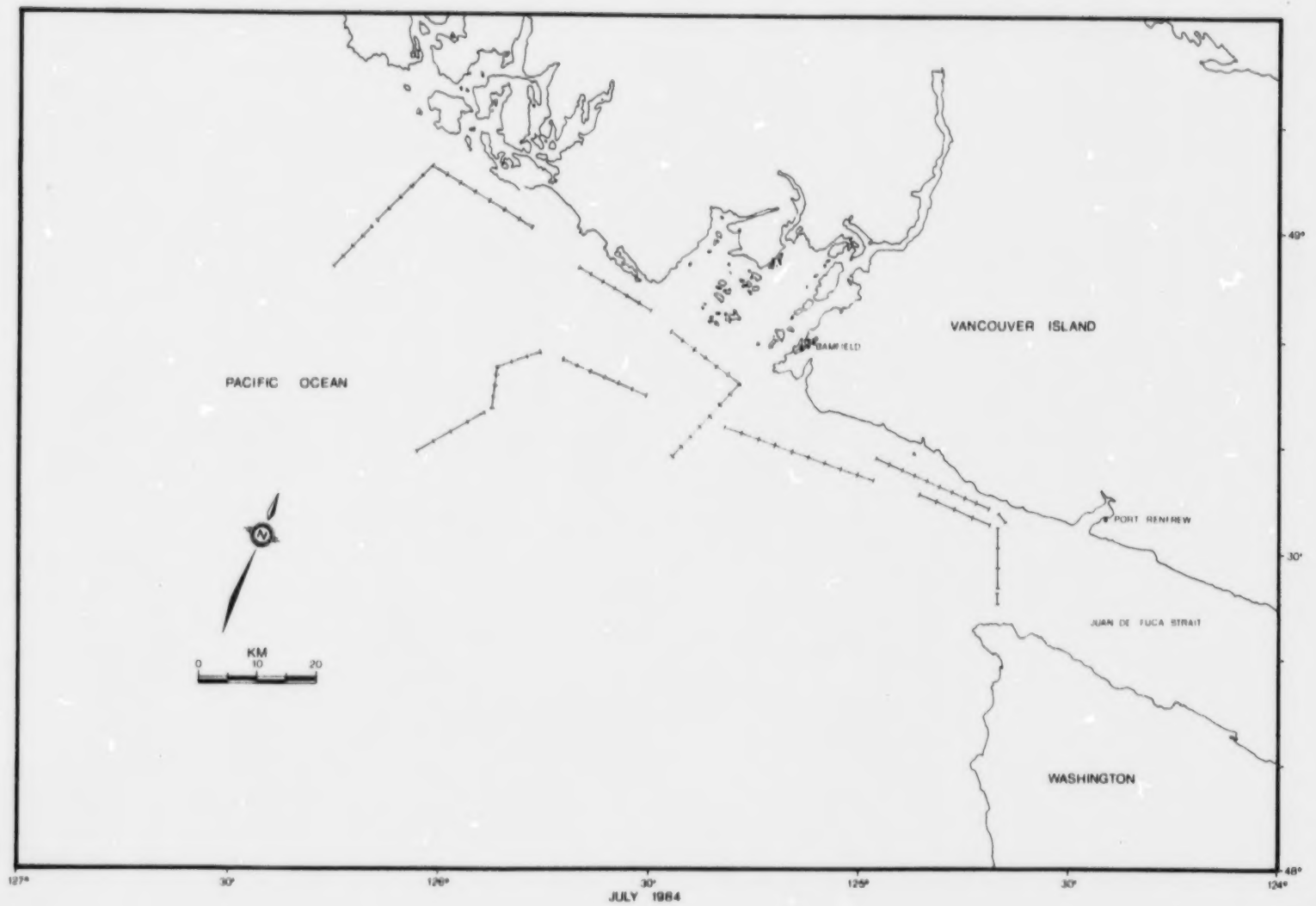


Figure 5. Location of survey transects during observations of marine birds off SW Vancouver Island, July 1986.



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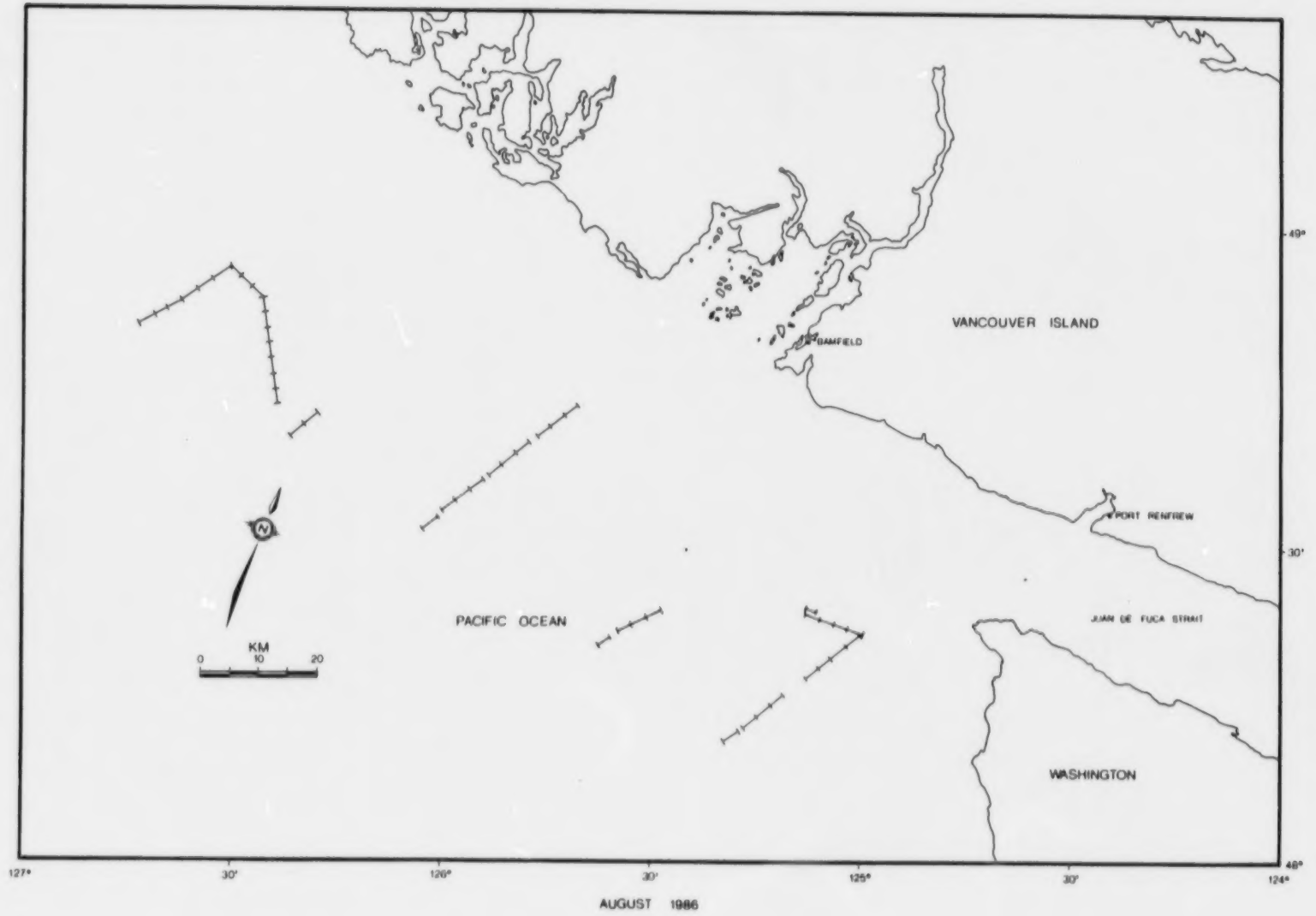

Figure 7. Location of survey transects during observations of marine birds off SW Vancouver Island, August 1986.

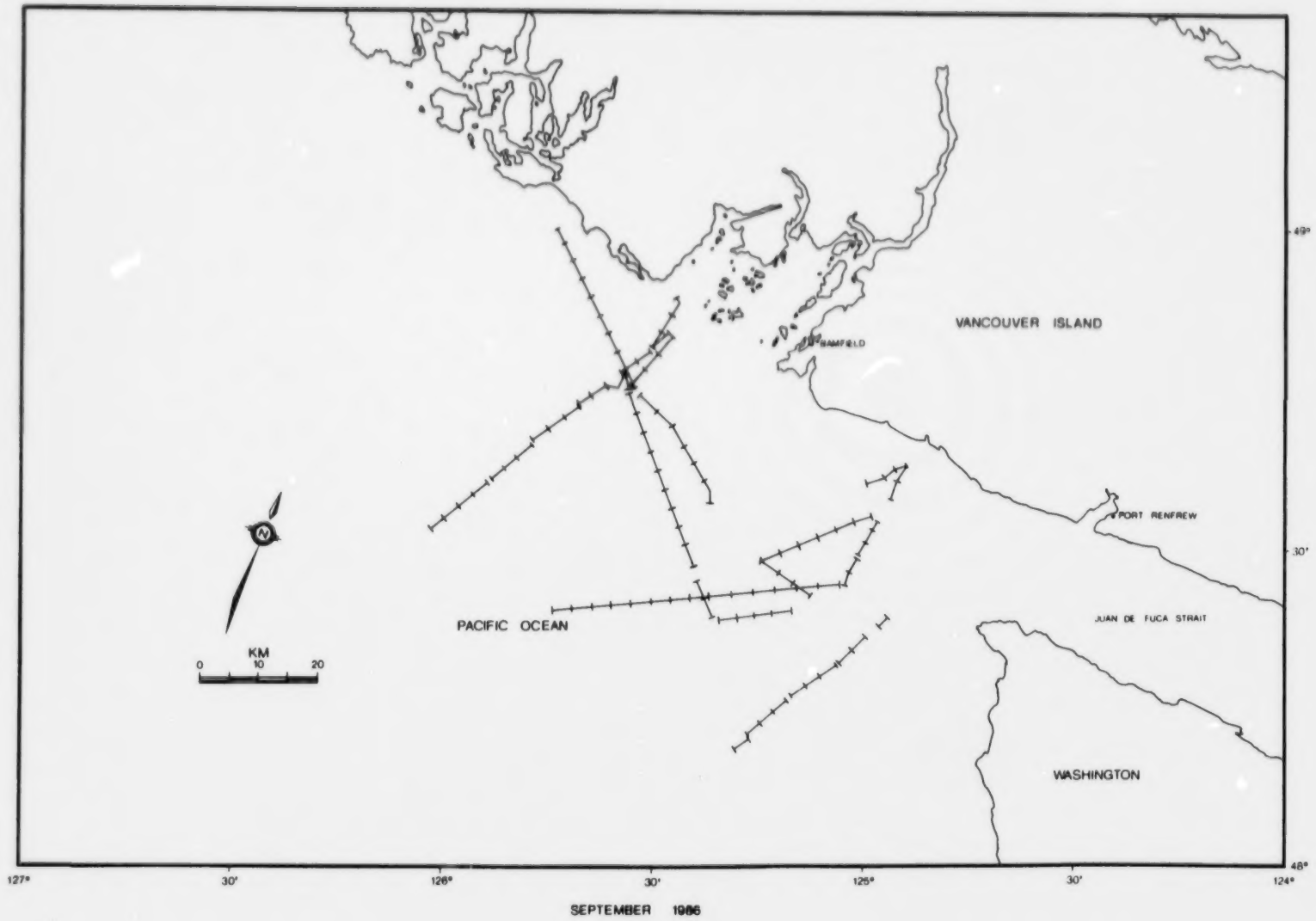

Figure 8. Location of survey transects during observations of marine birds off SW Vancouver Island, September 1986.

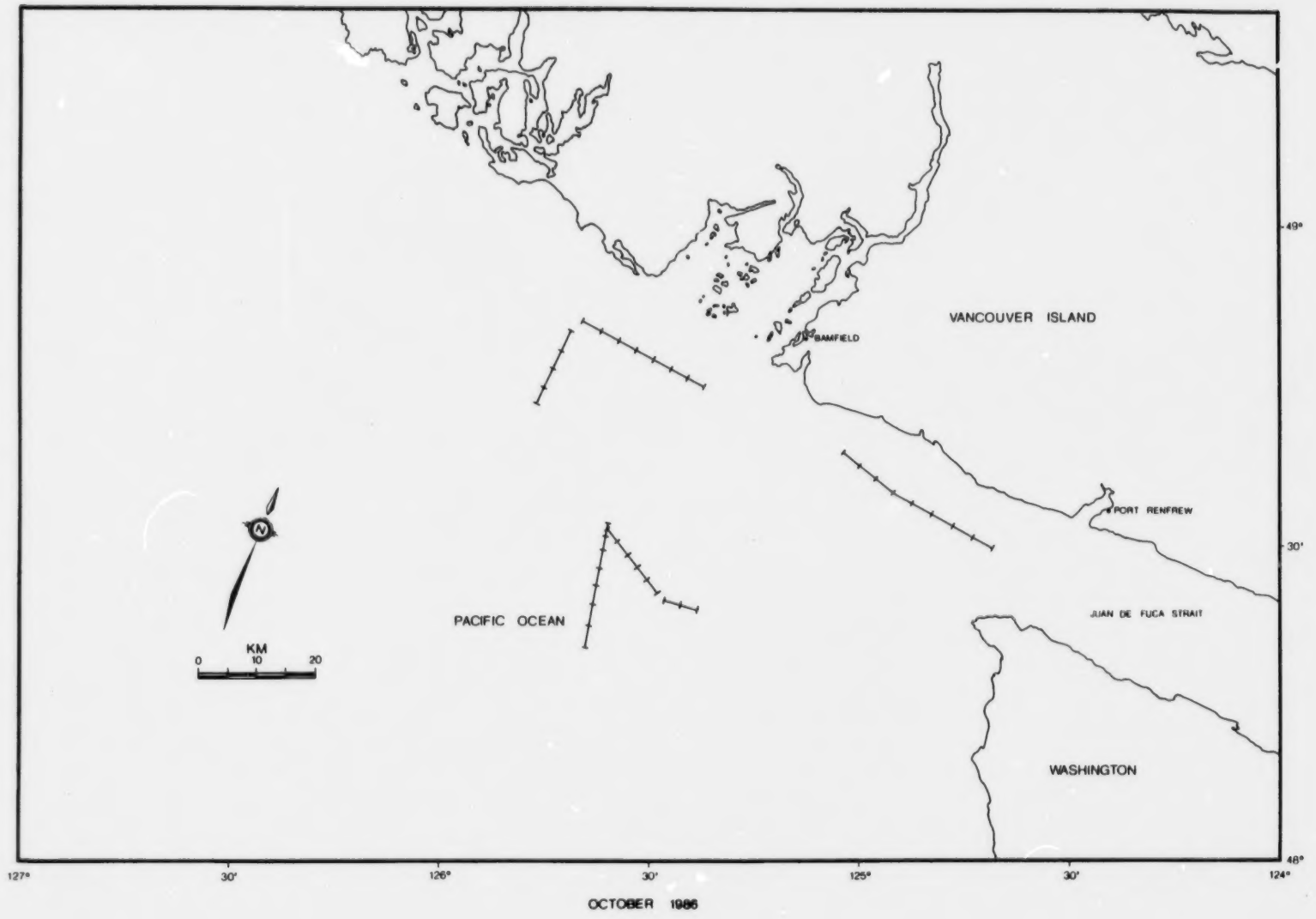

Figure 9. Location of survey transects during observations of marine birds off SW Vancouver Island, October 1986.

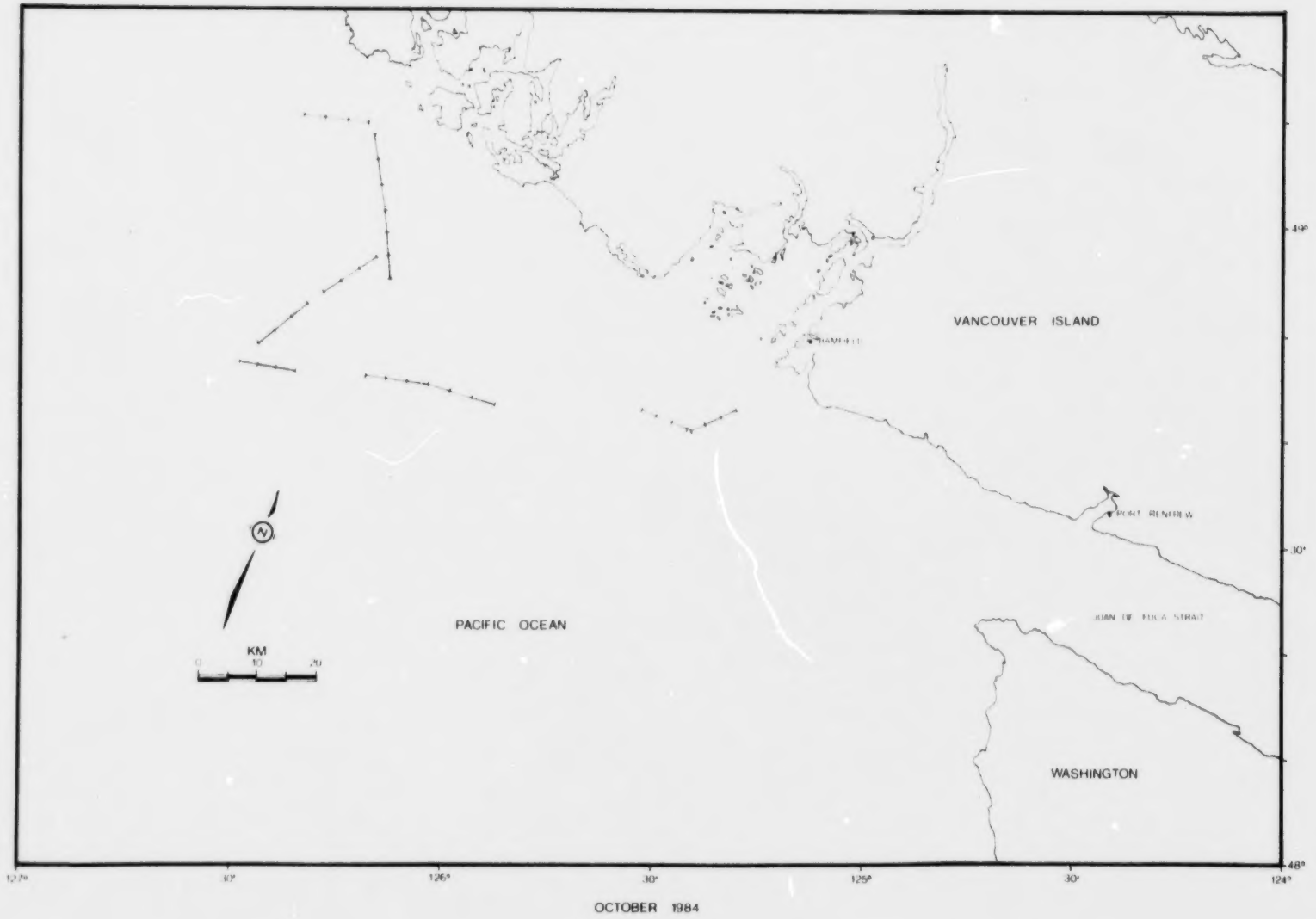

Figure 10. Location of survey transects during observations of marine birds off SW Vancouver Island, October 1984.

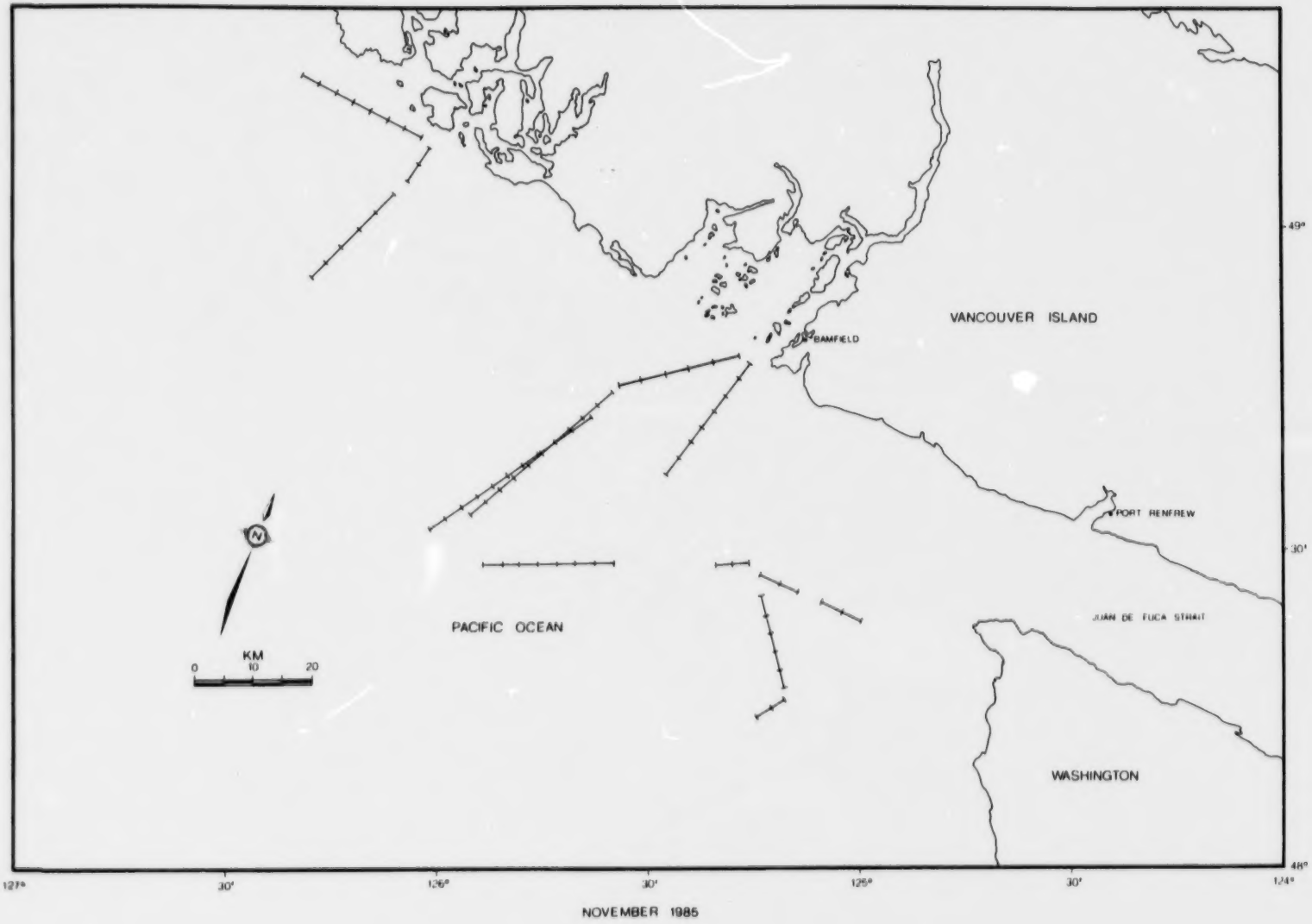

Figure 11. Location of survey transects during observations of marine birds off SW Vancouver Island, November 1985.